

# PATENT SPECIFICATION

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 (72) Inventor YOSUKE SAGAMI



## (54) ELECTROLYTIC PAPER

(71) We, THE DEXTER CORPORATION, a corporation organised under the laws of the State of Connecticut, United States of America, of One Elm Street, Windsor Locks, Connecticut, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to an electrolytic paper, which may be used as a dielectric in condensers.

At present Kraft paper made from sulfate pulp is principally used as the electrolytic paper. Although Kraft paper has an advantage in that it is relatively cheap, it has a disadvantage in that it is not available in 100% purity on an industrial scale and always includes 2—3% lignin and other impurities such as dust or iron. On the other hand, an electrolyte also contains impurities such as iron or the like. In condensers, these impurities move toward the anode, which is generally made of an aluminium foil, and attack it. Furthermore, Kraft paper has another disadvantage in that its low-temperature performance and frequency characteristic as an electrolytic paper is very poor in a low temperature range such as 20°C to -45°C. In contrast to Kraft paper, Manilla paper made from Manilla hemp is known to have a high purity and fine fibers which contain no lignin and, therefore, the paper is suitable for use as an electrolytic paper for condensers. However, Manilla paper is more expensive than Kraft paper and, accordingly, it has not been widely used as a substitute for Kraft paper. In view of these advantages and disadvantages of Kraft paper and Manilla paper, attempts have been made to mix Manilla hemp fibres with sulfate pulp thereby providing electrolytic papers having a medium characteristic with regard to cost and performance. However, the impurities such as lignin contained in the sulfate pulp, even in a little amount, will attack the anode, and once corrosion has started, it will gradually

spread and if a hole is formed at any portion of the anode, it will render the condenser inoperative as a whole. Therefore, the method of mixing Manilla hemp fibers with sulfate pulp does not provide an improvement in the performance of the electrolytic paper such as to be directly proportional to the amount of the Manilla hemp fibers in the mixture.

It has now been found that a significant improvement in combating corrosion of the anode is obtained when the electrolytic paper is made from sulfate pulp in a multilayered form, instead of in the form of a single layered paper. The reason for this improvement is guessed to be that a boundary space formed between two adjacent layers in the multilayered paper captures the impurities such as lignin or the like contained in the sulphate pulp and iron or the like contained in the electrolyte, thereby serving as a buffering filter against the impurities and that a locally increased liquid holding capacity due to the boundary space prevents the progress of the corrosion.

The present invention now provides an electrolytic paper that comprises at least two layers, wherein at least one of the layers providing one of the opposite surfaces of the paper comprises hemp (especially Manilla hemp) fibres and is substantially free of lignin.

The paper of this invention can be used in a capacitor, the layers of the paper being arranged transversely to the electrodes of the capacitor.

The electrolytic paper of the present invention is, in one of its simplest embodiments, a two-layered electrolytic paper having one Kraft paper layer made from sulfate pulp and one Manilla paper layer made from Manilla hemp fibres laid over each other. This electrolytic paper is of course used in a manner such that its Manilla paper layer contacts an anode element such as an aluminium foil and its Kraft paper layer contacts a cathode element. When this laminated electrolytic paper is used, the

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electrolytic paper layer which contacts an anode element is the Manilla paper having a high purity, whereby the corrosion caused by the impurities is significantly reduced.

5 Moreover, since the Manilla paper layer generally has a larger capacity for holding liquid than the Kraft paper, the rate of propagation of the corrosion across the paper layer is relatively low. Furthermore, as mentioned above, an area having a particularly large capacity for holding liquid is formed in the boundary region located between the Manilla paper layer and the Kraft paper layer and, accordingly, the propagation of the corrosion is also greatly impeded in the boundary region. Therefore, the rate at which the corrosion propagates from the cathode to the anode across the entire paper layer is significantly reduced.

10 The electrolytic paper in accordance with the present invention may, of course, be produced by separately making individual paper layers and thereafter merely laying one over the other. However, such a paper has a drawback in that it is loose and inconvenient for handling, thereby complicating the manufacturing process of condensers. Therefore, it is more desirable that the electrolytic paper in accordance with the present invention is produced to have an integral structure wherein some fibers are intermingled between the adjacent layers sufficiently to mechanically couple them together while defining a distinct boundary therebetween by simultaneously making the individual layers and combining them together.

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#### EXAMPLE

A preferred embodiment of the laminated electrolytic paper in accordance with the present invention may have the following physical properties:

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Total Density:  
Approx 0.5 g/cm<sup>3</sup>  
Thickness:  
45 50 micron  
(25 micron—Manilla)  
(25 micron—Kraft)  
Resistivity:  
Above 50,000  $\Omega$ /sheet

Water absorbency: 50  
Above 100 mm. measured by  
water rise in a paper 14 mm.  
wide in 50 minutes  
Specific weight:  
25 g/m<sup>2</sup> 55  
Tensile Strength:  
MD-MINI 1700 (g/15 mm)  
CD-MINI 514 (g/15 mm)

In the above basic embodiment, the laminated electrolytic paper in accordance with the present invention has been described as having one Kraft paper layer and one Manilla paper layer. However, in order to increase the effects of capturing impurities and of suppressing corrosion two or more Kraft-paper layers and/or two or more hemp layers may be provided.

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#### WHAT WE CLAIM IS:—

1. An electrolytic paper that comprises at least two layers, wherein at least one of the layers providing one of the opposite surfaces of the paper comprises hemp fibres and is substantially free of lignin. 70
2. A paper according to Claim 1, in which the said layer that is substantially free of lignin is made of Manilla hemp. 75
3. A paper according to Claim 1 or 2, which comprises a layer of Kraft paper.
4. A paper according to Claim 1, 2 or 3, in which the layers are joined by the intermingling of fibres at the interface between adjacent layers. 80
5. An electrolytic paper substantially as described in the Example.
6. A capacitor, the electrolytic material of which comprises a paper according to any of Claims 1 to 5, the layers of the paper being arranged transversely to the electrodes of the capacitor. 85
7. A capacitor according to Claim 6, in which the surface of the paper formed by the layer comprising hemp fibres is adjacent the anode. 90
8. A capacitor according to Claim 7, in which the anode is of aluminium foil. 95

For the Applicants,  
CARPMAELS & RANSFORD,  
Chartered Patent Agents,  
43 Bloomsbury Square,  
London, WC1A 2RA.